NPAFC
Doc. 418
Rev.

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by

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Submitted to the
NORTH PACIFIC ANADROMOUS FISH COMMISSION
by
JAPAN

October 1999

THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER:
Kawana, M., K. Umeda, G. Kawakami, and Y. Matsushita. 1999. High-seas salmonid research aboard the R/V *Wakatake-maru* in the central North Pacific Ocean and Bering Sea in the summer of 1999. (NPAFC Doc. 418). 28 p. National Salmon Resources Center, Fisheries Agency of Japan, 2-2 Nakanoshima, Toyohira-ku, Sapporo 062-0922, Japan.

HIGH-SEAS SALMONID RESEARCH ABOARD THE R/V *WAKATAKE MARU* IN THE CENTRAL NORTH PACIFIC OCEAN AND BERING SEA IN THE SUMMER OF 1999

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Abstract

An annual high-seas salmonid research cruise was conducted in the central North Pacific Ocean and Bering Sea from June 7 to July 23, 1999, on board the Japanese research vessel *Wakatake maru* to investigate salmon stock condition. The research cruise activities included collection of data on oceanography, primary production, zooplankton, salmonids, and other organisms. Oceanographic data indicated that the average sea surface temperature (SST) in the central North Pacific was 7.8°C (1.3°C cooler than in 1998) and the average SST in July in the Bering Sea was 6.5°C (0.8°C cooler than in 1998). A total of 12,568 salmonids (*Oncorhynchus* spp.) were caught by longline and gillnets. In the central North Pacific Ocean, pink salmon (*O. gorbuscha*) was most abundant (28% of the salmonid catch), followed by chum salmon (*O. keta*; 27%), coho (*O. kisutch*; 22%), sockeye (*O. nerka;* 17%), steelhead trout (*O. mykiss*; 3%), and chinook salmon (*O. tshawytscha*; 1%). In the central Bering Sea, pink salmon was most abundant (79% of the salmonid catch), followed by chum (16%), sockeye (4%), and chinook salmon (1%). We collected the stomach samples from 1,387 salmonids including 284 sockeye, 456 chum, 535 pink, 40 coho, 54 chinook salmon and 18 steelhead trout. Tissue samples were collected from 716 chum salmon for genetic stock identification. Otoliths samples were collected from 705 chum and 558 pink salmon for

stock identification by thermal marks. Tissue samples were collected from 115 chum and 104 pink salmon for estimating trophic condition. A total of 394 salmonids were double-tagged with disk tags and released to the sea. Most of these fish were chum salmon (n=241), but pink (n=134), sockeye (n=16), coho (n=5), and chinook salmon (n=2) were also tagged and released. Ten disk-tagged fish (3 sockeye salmon in the central North Pacific Ocean and 7 chum salmon in the central Bering Sea) were released with an externally attached temperature-recording archival tag. Twenty-six disk-tagged chum salmon were released in the central Bering Sea with an internally inserted temperature, depth, and location recording archival tag.

Introduction

The main objective of this research cruise is to monitor and estimate stock condition of salmonids (*Oncorhynchus* spp.) in the central North Pacific Ocean and the Bering Sea. A recent decrease in body size and increase in age of mature salmon has been reported (Kaeriyama, 1989; Ishida et al., 1993; Helle and Hoffman, 1995; Bigler et al., 1996). To investigate these issues, a survey including collection of data on physical oceanography, primary production, and relationships of zooplankton, salmonid, and higher trophic levels is needed. Since 1991, the Fisheries Agency of Japan (FAJ) has annually chartered the R/V *Wakatake maru* to conduct a salmon monitoring survey in June and July.

The 1999 salmon research cruise of the *Wakatake maru* is the ninth survey in this series, which is conducted at established locations in the central North Pacific Ocean and Bering Sea (Ishida et al., 1991, 1992; Davis and Tadokoro, 1994; Nagasawa et al., 1994; Myers et al., 1995; Davis et al., 1996; Nagasawa et al., 1997; Ueno et al., 1998). The fishing operations are located along a latitudinal gradient, beginning at 39°00 N, which is south of salmon distribution in summer, and progressing northwards through the central Aleutian Islands into the international waters of the central Bering Sea. The survey includes longline and gillnet operations in the international waters of the central North Pacific Ocean and Bering Sea and longline fishing operations within the U.S. 200-mile EEZ north and south of the central Aleutian Islands. During the cruise series, we employ the same basic methodology for measuring salmon abundance and salmon biological characteristics. The surveys have developed a time series including data on oceanography, primary production and zooplankton abundance, and salmonid biological data by returning annually to the same locations.

In addition, the 1999 research cruise provided an opportunity for a variety of other studies including salmonid food habits, chum (*O. keta*) and pink salmon (*O. gorbuscha*) stock identification, salmon tagging (disk and archival tags), estimation of trophic conditon of chum and pink salmon, and gonadotrophic hormone releasing hormone (GnRH) transplantation to chum salmon. This cruise report summarizes our sampling methods, and briefly reviews results of the samplings.

Methods

Research Vessel, Survey Area, and Ship's Schedule

The *Wakatake maru* (666 gross tons) was chartered by Japan Marine Fishery Resource Research Center (JMFRRC) from June 7 to July 23 to conduct salmon monitoring research. The FAJ financially supported the JMFRRC for this research.

The *Wakatake maru* departed Hakodate, Japan, on June 8, 1999 and returned to Hakodate on July 22, 1999 (Table 1). There were 28 experimental fishing stations during this cruise (Fig. 1). Twenty-one fishing stations were located in the vicinity of 180°00' longitude from 39°00'N to 58°30'N latitude, and seven operations were conducted in the international waters of the central Bering Sea. Oceanographic data were collected at each fishing station and between stations. Additional oceanographic data were collected enroute to and from the fishing area (Fig. 1).

Physical Oceanography

Physical oceanographic data were collected using an expendable bathythermograph (XBT), expendable conductivity-temperature-depth probe (XCTD), and a conductivity-temperature-depth sensor (CTD; Tables 2 and 3). At transit stations located along 40°00'N latitude (n=31), temperature and depth data were collected by XBT or XCTD for a depth of approximately 780 m (XBT) or 1,000 m (XCTD) (Fig. 1, Table 2). At transit stations located at most of intervals of 5° longitude (n=11), and of the fishing stations (n=27), physical oceanographic observations were conducted with CTD for a depth of approximately 1,000 m. However, under rough sea condition, physical oceanographic observation was conducted with XCTD at one fishing station (ST-8) or the observation was not conducted at one transit station (T-21; Table 2). At transit stations along the oblique line from the international waters of the

Bering Sea to the offshore waters of Japan, XCTD were used for collecting physical oceanographic data (Table 3).

Primary Production

Phytoplankton samples were collected at 21 fishing stations (ST 1-21) along a south to north transect and at 12 transit stations located at an interval of 5° longitude (Fig. 1). Seawater was collected at 0 m using a bucket. Chlorophyll-a was collected by vacuum-filtering (100-120 mm Hg) 100-ml of seawater through a 25-mm glass-fiber filter (Whatman GF/F). Filters containing the chlorophyll-a were soaked with 6-ml of N-dimethylformaide and kept in the dark in the freezer. All the samples were sent to the Hokkaido National Fisheries Research Institute (HNF), Kushiro, Hokkaido for analysis.

Zooplankton Collection

Macro-zooplankton were sampled with a remodeled Norpac net at 28 fishing stations and 6 transit stations located at intervals of 5° longitude from 150°00'E to 160°00'E (Table 4; Motoda, 1994). The net was towed vertically from 150 m to the surface. A calibrated flow meter was attached to the opening of the net in a position slightly off-center. Samples were fixed in 5% borax-buffered formalin in seawater and sent to the HNF for analysis.

Large macro-zooplankton were collected at 28 fishing stations using a fish larval net (1.3 m ring diameter, 4.5 m net length, 0.335-2.0 mm mesh size; Table 4). The fish larval net was towed horizontally at the surface for 10 minutes around 23:00. Samples were fixed in 10% borax-buffered formalin in seawater and sent to the HNF for analysis.

Fishing Operations

A gillnet and longline were used for experimental fishing operations to collect salmonids and other pelagic fish (Table 5). The gillnet was used at 10 stations in the central North Pacific Ocean and 11 stations in the central Bering Sea, outside of the U.S. 200-mile EEZ (Fig. 1, Table 2). The gillnet was set at 16:00 in the afternoon (Local Mean Time [LMT], GMT+12) and retrieved at 04:00 in the following morning. The gillnet configuration consisted of variable-mesh gillnets (C-gear: 3 tans each of 48, 55, 63, 72, 82, 93, 106, 121, 138, and 158 mm mesh size, each tan is 50 m long) and commercial-mesh gillnet (A-gear: 19 tans of 115 mm mesh size, one tan is 50 m long; Table 5). However, at seven fishing stations (ST 1-7) at the southern end of the transect, the number of tans of A-gear was reduced from 19 to 17 tans, and two tans of smaller

mesh size (F-gear: one tan of 29, and 37 mm mesh size, each tan is 25 m long) were substituted in order to collect pacific saury. The C-gear was placed in the middle of two sections of A-gear, and the F-gear was placed at one end of the A-gear. The longline was used at 24 fishing stations (ST 1-4 and 9-28; Fig. 1, Table 5). At stations 5 to 8, the longline was not operated because of lack of bait. The longline was set 30 minutes before sunset and hauled 30 minutes after sunset (LMT). The longline comprised 30 hachi (overall length 3.32 km; 1 hachi is 110.68 m long with 49 hooks) and was baited with salted Japanese anchovy (*Engraulis japonicus*). Quality of the bait used at stations 9 to 28 was poor, some of the bait were not enough hard to keep on hook during a operation. Because the bait was salted abnormally, it had been stored frozen and it was salted just before the operations, instead of bait has been stored salted in general operations.

Fish Examination

Salmonids were processed soon after removal from the fishing gear. For each mesh size, the catch was sorted and counted by species. We collected biological data from a maximum of 60 individuals of each species from each mesh size (gillnet operation, mesh sizes=13) and from a maximum of 60 individuals per species from longline mortalities. The biological data included fork length (FL, mm), body weight (BW, g), sex, and gonad weight (GW, g). One scale (sockeye [*O. nerka*], chum, and pink salmon [*O. gorbuscha*]), two scales (coho [*O. kisutch*] and chinook salmon [*O. tshawytscha*]), or a scrape sample (steelhead [*O. mykiss*] were collected. Scales were collected from the INPFC (International North Pacific Fisheries Commission) preferred area on the body for age determination (Davis et al., 1990). The presence of external injuries on salmon and visceral adhesion in sockeye salmon were recorded (Nagasawa et al., 1997). Salmonids were inspected for the presence of clipped adipose fins. If the fish had a clipped adipose fin, the snout was removed, salted, and frozen for later potential recovery of a coded-wire tag.

All non-salmonid catches were identified and counted by mesh size. Body lengths were measured for non-salmonid fish, squid, and other organisms, and a few were frozen for later taxonomic and ecological studies.

Salmonid Stomach Content Examination

Salmon and steelhead stomachs were collected from a maximum of 10 fish per species from longline mortalities and a maximum of five fish per species from each of all gillnet mesh sizes of C-gear. The samples from five mesh sizes (48, 63, 82, 106, and 138

mm) were fixed in 10% borax-buffered formalin in seawater and sent to the HNF, and the others were frozen and sent to the Fisheries Research Institute (FRI), University of Washington, Seatle.

Disk Tagging

Live salmon caught in a healthy condition, i.e., not bleeding and no damages on eyes by the hook, were put into a recovery tank soon after removal from the longline. Fish were tagged with two disk tags: one issued by the FAJ and a second disk tag issued by FRI. Both disk tags were placed on one plastic cinch strap and applied to the fish anterior to the dorsal fin. Tagged fish were measured for fork length and two scales were collected before the fish was released to the sea. Some disk-tagged fish were released with an archival tag or treated for the hormone experiments.

Archival Tagging

A few of the disk-tagged fish were selected for tagging with archival tags. Archival tags are data loggers that contain sensors (for physical conditions such as temperature, light, and depth) capable of recording data into computer memory for retrieval at a later time. We used two types of archival tags. One type of archival tag, manufactured by the Kiwi Group, North Falmouth, MA, records seawater temperature (Walker et al., 1998). The Kiwi tag is referred to a temperature tag in this report. A second type of archival tag manufactured by Northwest Marine Technology (NWT), Shaw Island, WA, records the fish's internal temperature, seawater temperature, light levels (for location), and depth. In this report, the NWT tag is referred to as an archival tag.

Our purpose was to put temperature and archival tags on fish that had an increased likelihood of returning to fresh water relatively soon and that had a good chance of being caught in coastal or freshwater fisheries. In the central North Pacific Ocean, sockeye salmon were released with a temperature tag. In the central Bering Sea, large maturing Japanese-like chum salmon were selected for tagging with either a temperature tag, or an archival tag. We used subjective criteria to evaluate if a large chum salmon was likely to be maturing. The scale pattern criterion we used to "identify" Japanese chum salmon was if the circuli count in the first year was greater than or equal to 30, then we considered the fish to be returning to Japan (Y. Ishida, HNF, Kushiro, personal communication).

To examine chum salmon scale patterns, a large healthy fish was removed from the recovery tank and placed individually into a second, smaller tank. A preferred scale

was removed from the chum salmon and viewed with a microscope to count the circuli in the first ocean zone. If the scale exhibited the scale pattern typical of a Japanese chum salmon, then the fish was selected for archival tagging. If chum salmon scale had other scale patterns, then the fish was just disk-tagged and released.

The temperature tag was secured to the fish using two metal pins. The pins were placed through holes on both sides of the temperature tag and then the tag-and-pin assembly was pushed through the dorsal muscle of the fish a few centimeters anterior to the dorsal fin (Walker et al., 1998). The pins were threaded through the holes in the FAJ and FRI disk tags on the opposite side of the fish from the temperature tag and the pins were twisted into a knot with pliers. After finishing affixing the temperature tag to the fish, the fish was released to the sea.

The archival tag was placed in the visceral cavity of chum salmon. No anesthetics were used for the fish. The fish was disk-tagged and then turned over onto its back. A length-wise incision, approximately 4-cm long, was cut between the pelvic fins and the anal fin slightly to the left of the ventral midline. The tag was inserted into the body cavity and the external sensor wire was allowed to trail out of the fish at the site of the incision. The incision was closed with two stitches. After the operation was completed, the fish was immediately released to the sea.

In addition, a dummy archival-tag, manufactured by National Institute of Polar Research, was tagged for the first step of future research. The dummy tag was secured to the fish using two cinch straps. After finishing affixing the dummy tag to the fish, the fish was released to the sea.

Archival-Tag Tank Experiment

An archival tag was surgically placed into a few salmonids in order to observe the influence of the operation and the presence of the archival tag on the survival of the fish. These fish were caught by longline and selected because they were large and were thought to be good candidates for archival tagging. After insertion of the tag, the fish was placed into a large (1-ton capacity) tank placed on the rear deck of the ship in the open air. Fresh seawater was constantly supplied to the tank. Fish were observed periodically until they died, after which time they were dissected to observe the condition of the visceral cavity, the site of the incision, and the general body condition.

Other Sampling and Research

Tissue samples (muscle, heart, liver, and pectral fin) were collected from chum salmon for genetic stock identification. The four tissues from each fish were combined

into individual small plastic bags, labeled with individual sample numbers, and stored frozen at –50°C.

A pair of otoliths (sagitta) were collected from chum and pink salmon for stock identification by thermal marks. The otoliths were cleaned and stored dry in small plastic boxes with individual sample labels.

Tissue samples (white muscle and liver) were collected from chum and pink salmon for estimating trophic condition using total lipid content and lipid classes. White muscle samples were stored frozen at -50°C in small plastic bags, labeled with individual sample numbers. Some pink salmon were stored as the whole body for lipid analysis.

Tissue samples (olfactory organ, brain, pituitary, gonad, head kidney, liver, and muscle) were collected from chum salmon for analysis of gonadotrophic hormone releasing hormone (GnRH). A subset of disk-tagged chum salmon was taken a blood sample, transplanted GnRH, and released in the sea. Another subset of disk-tagged chum salmon was taken a blood sample, injected only medium, and released in the sea. Blood samples were collected 1 ml from the caudal vein using a syringe. Transplant and injection were conducted by syringe.

Results and Discussion

Physical Oceanography

Station 1 (39°00'N) were located in the Transition Zone, characterized by surface salinity greater than 34.0 practical salinity units (psu; Dodimead et al., 1963; Favorite et al., 1976; Fig. 2). The position of the Subarctic Boundary (vertical 34.0 psu isohaline) was located between 39°00'N and 40°00'N (between stations 1 and 2). This boundary was located north in 1991-1998 (41°N-43°N; Davis et al., 1996; Nagasawa et al., 1997; Ueno et al., 1998).

The Transition Domain, which is defined by salinity greater than 33.2 psu at the surface and greater than 33.4 psu at the bottom of the upper layer, was located between 40°00'N and 42°00'N (stations 2 to 4; Dodimead et al., 1963; Favorite et al., 1976; Fig. 2). The Subarctic Current at 180°00' longitude is identified by water temperature of 3.5°C and by salinity of 33.4 psu at approximately 125 m. This eastward-flowing current has cool, dilute surface waters and relatively homogeneous conditions. The Subarctic Current was located at 46°00'N to 48°30'N (stations 8 to 11; Fig. 2). The Ridge Domain was located at 49°30'N (station 12), where cold, saline water comes up from the depths

and the 4°C isotherm is located at less than 100 m. The Alaska Stream flows westward with warm (>4°C), dilute water (<32.6 psu at less than 100 m) and was located at 50°30'N (station 13; Fig. 2).

Stations 15 through 28 (52°30' to 58°30'N) were located geographically in the Bering Sea. The Bering Sea has cold, saline surface waters (Fig. 2).

Sea surface temperatures (SST) were cooler in 1999 than in 1998. In 1999, the average SST was 1.3°C cooler than in 1998 in the central North Pacific (stations 1-14; mean=9.1°C in 1998 and 7.8°C in 1999). The same was true in the Bering Sea, where the average July SST was 0.8°C cooler in 1999 than in 1998 (stations 15-28; mean=7.3°C in 1998 and 6.5°C in 1999).

Salmonid Catches

A total of 12,568 salmonids was caught by longline and gillnet (Table 6). Six percent of the total salmonid catch was caught in the central North Pacific Ocean (Stations 1-14) and 94% of the salmonid catch was caught in the central Bering Sea (Stations 15-28). The salmonid species composition was different between the two areas. In the North Pacific Ocean, pink salmon was the most abundant salmon (28% of the salmonid catch), followed by chum salmon (27%), coho salmon (22%), sockeye salmon (17%), steelhead trout (3%), and chinook salmon (1%; Table 6). In the Bering Sea, pink salmon was the most abundant salmon (79% of the salmonid catch), followed by chum salmon (16%), sockeye salmon (4%), chinook salmon (1%; Table 6).

Snout Recovery from Adipose Fin-clipped Salmonids

Eight steelhead snouts were collected from fish missing the adipose fin. Three of these fish also had ventral fin clip. The snouts were frozen, and sent the to Auke Bay Laboratory, Juneau, AK, for dissection and potential recovery of coded-wire tags.

Non-salmonid Catches

Pacific pomfret (*Brama japonica*, n=285), neon flying squid (*Ommastrephes bartrami*, n=533), and Pacific saury (*Cololabis saira*, n=88) were the most abundant non-salmonid caught in the southern stations of the central North Pacific. In 1999 the northern-most catch of neon flying squid, Pcific pomfret and Pacific saury was 42°00'N latitude (SST=8.6°C, Table 6). In 1998 the northernmost catches for flying squid and saury was 42°00'N and the northern boundary for distribution of Pacific pomfret was 43°00'N (Ueno et al., 1998).

Salmonid Distribution and Relative Abundance

Salmonids were distributed in waters north of 42°00’N latitude. Sockeye salmon was distributed north of 46°00’N latitude (Fig. 3). Chum and pink salmon were distributed north of 42°00’N latitude (Fig. 3). Coho salmon was abundant in the central North Pacific between 42°00’N and 47°30’N, but few coho salmon were caught in more northerly waters (Fig. 3). Chinook salmon was caught north of 46°00’N, and relatively abundant in the northern waters of the central Bering Sea (Fig. 3). Steelhead trout was caught in the central North Pacific from 42°00N to 47°30’N, but not caught in waters near the Aleutian Islands or in the Bering Sea (Fig. 3).

Relationship Between Salmonid Distribution and Oceanographic Features

There are two oceanographic areas where salmonids are more abundant on this transect than in the northern area (Figs. 2, 3). One area is in the south, located from 46°N to 48°30’N, which corresponds to the location of the Subarctic Current. A second area is located north of 55°30’N, in the central Bering Sea. Sockeye, chum, pink, and chinook salmon were abundant in this area (Fig. 3).

Salmonid Stomach Content Examination

We collected the stomach samples from 1,387 salmonids including 284 sockeye, 456 chum salmon, 535 pink salmon, 40 coho salmon, 54 chinook salmon, and 18 steelhead trout.

Disk Tagging

A total of 394 salmonids were double-tagged with disk tags and released to the sea (Table 6). Most of these fish were chum salmon (n=241), but pink (n=134), sockeye (n=16), coho (n=5), and chinook salmon (n=2) were also tagged and released. One double-tagged pink salmon was recaptured when gillnet fishing. The pink salmon was released at 58°30’N, 180°00’ on July 7 and recovered on July 8 (FL=470mm, BW=1150g, disk tag number=HH2287, LL3058). The fish was recovered the next moring at locations where they were released the previous night.

Archival Tagging

A subset of the disk-tagged fish was released with an externally attached temperature tag. Three sockeye salmon were released in the central North Pacific Ocean with temperature tags (Table 7). Seven chum salmon were released in the central Bering

Sea with temperature tags. These chum salmon had patterns on their scales similar to the scale patterns of Japanese chum salmon.

Twenty six chum salmon with an internally inserted archival tag were released in the central Bering Sea (Table 9). These chum salmon also had patterns on their scales similar to the scale patterns of Japanese chum salmon. One chum salmon missing left ventral fin was tagged and released at 56°30'N, 178°00'E on July 14 (FL=590 mm, disk tag number=HH2501, LL3272, archival tag number=894).
One chum salmon with an externally attached dummy-archival tag was released at 56°30'N, 178°00'W on July 10 (FL=602mm, disk tag number=HH2364, LL3135).

Archival-Tag Tank Experiments

One sockeye and one chum salmon were tagged with an archival tag and kept in a large tank on the rear deck. One chum salmon, in which no incision was made and no dummy tag was inserted, was used as a blank test (disk tag number=HH2142, LL2913). One sockeye salmon, in which an incision was made but no archival tag was inserted, was also used as a blank test (HH2153, LL2924). All salmon, including the blank tests, died 4-7days after the injection. Dissection of the abdominal cavity revealed that the membrane covering the internal organs was not seriously damaged by an insertion of the tag. We think that the poor environment in the tank caused serious stress on the fish and reduced their viability due to cramped conditions, the ship's rolling, and other unknown conditions.

Other Sampling and Research

Tissue samples for genetic stock identification were collected from 716 chum salmon (196 from the North Pacific and 520 from the Bering Sea). Most of the fish were obtained from gillnet catches, but some fish caught by longline were used to supplement sample sizes. These samples were stored frozen and sent to Dr. Shigehiko Urawa of the National Salmon Resources Center (NASREC), Sapporo, for analysis.

Otoliths samples were collected from 705 chum salmon (192 from the North Pacific and 513 from the Bering Sea) and 558 pink salmon (180 from the North Pacific and 378 from the Bering Sea) for stock identification by thermal marks. In chum salmon samples, 698 samples were collected from same fish as tissue samples for genetic stock identification. Most of the fish were obtained from gillnet catches, but some fish caught by longline were used to supplement sample sizes.

Tissue samples for estimating trophic condition were collected from 115 chum salmon (51 from the North Pacific and 64 from the Bering Sea) and 104 pink salmon (50

from the North Pacific and 54 from the Bering Sea). Most of the fish were obtained from gillnet catches, but some fish caught by longline were used to supplement sample sizes. These samples were stored frozen and sent to Dr. Tetsuichi Nomura of the NASREC for analysis.

Tissue samples for analysis of GnRH were collected from 33 chum salmon obtained alive from longline catches. A subset of 40 disk-tagged chum salmon was taken a blood sample, transplanted GnRH, and released in the Bering Sea. Another subset of 38 disk-tagged chum salmon was taken a blood sample, injected only medium, and released in the Bering Sea.

Acknowledgements

We thank Captain Yoshiyuki Hayasaka and all the officers, crew, teachers, and students of the *Wakatake maru* for their collection of samples and data during the cruise. We also thank Dr. Shigehiko Urawa for his comments on the manuscript. The Fisheries Agency of Japan provided financial support for the research cruise.

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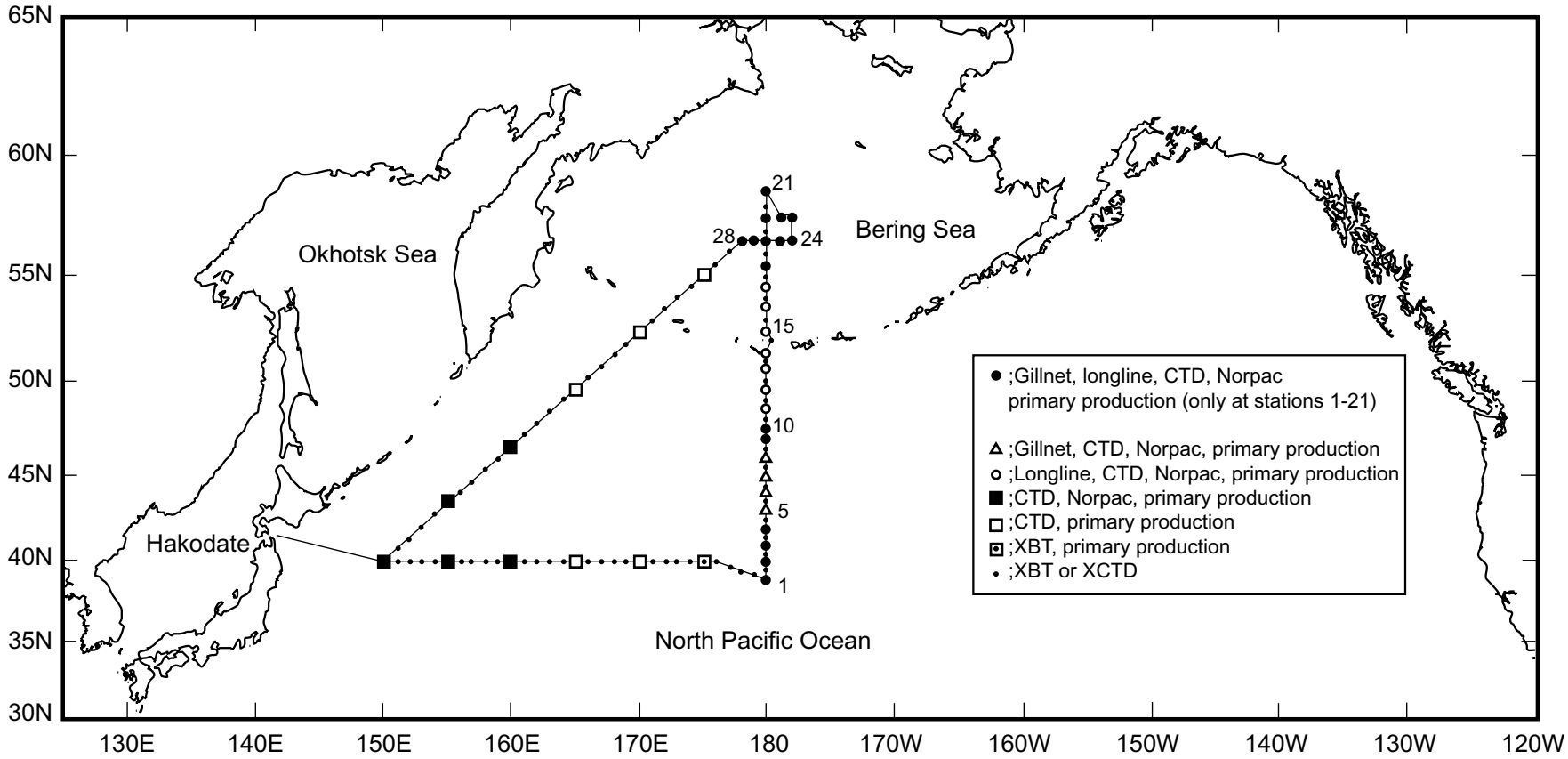

Fig. 1. Cruise track of the summer 1999 research cruise of the R/V *Wakatake maru*. The cruise track included 28 experimental fishing stations along a south to north transect at 180°00’ longitude from 39°00’N to 58°30’N latitude, and an east to west transect at 56°30’N latitude in the central Bering Sea. In addition, there were 77 transit stations located between fishing stations and enroute to and returning from the fishing area.

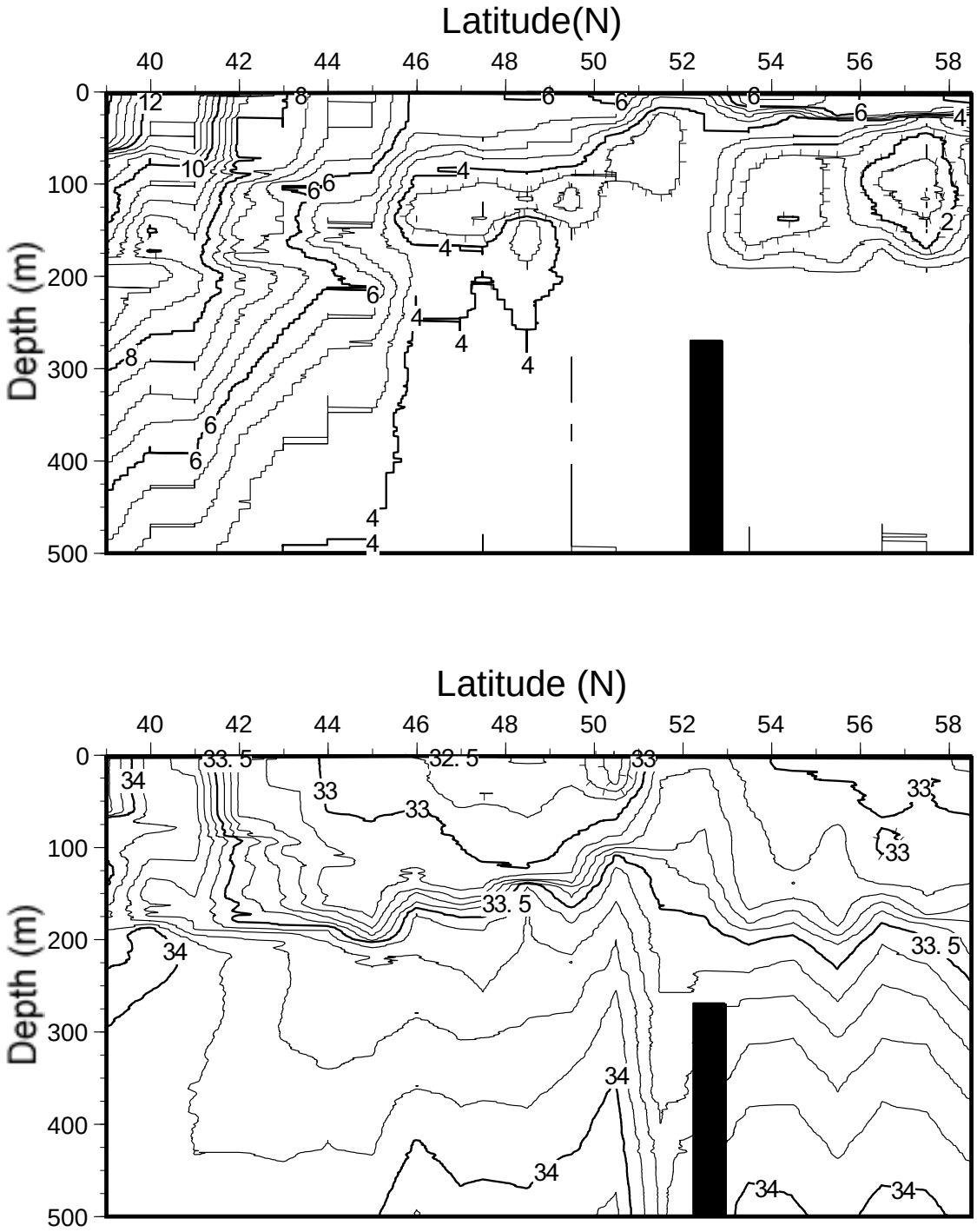

Fig. 2. Vertical profile of seawater temperature (upper, °C) and salinity (lower, psu) collected at 21 fishing stations along the south to north transect at 180°00' from 39°00'N to 47°30'N. Data were collected during fishing operations conducted by the *Wakatake maru*, 1999. Black area is the sea bottom.

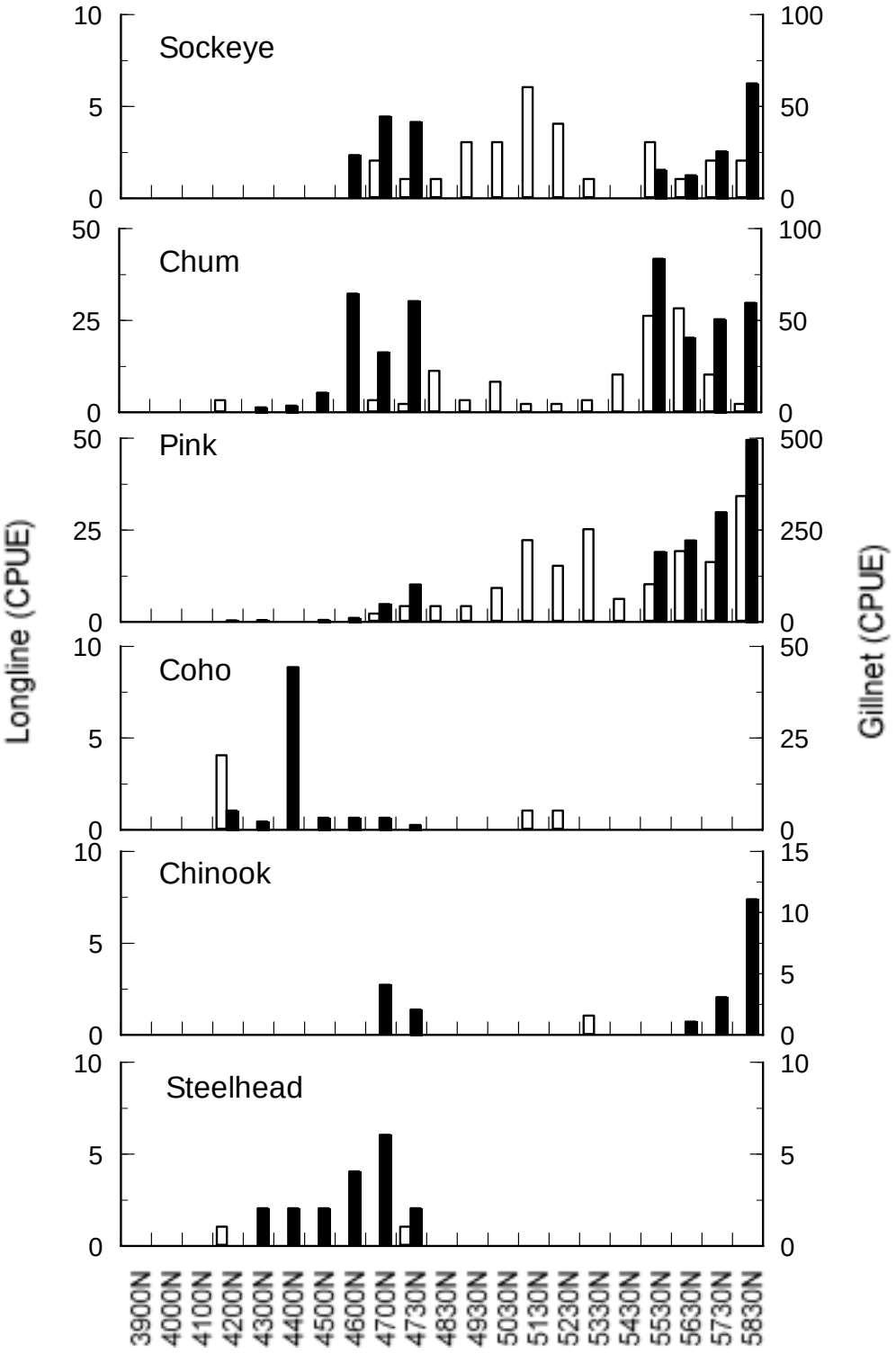

Fig. 3. Catch per unit of effort (CPUE) distributions are shown by species and fishing gear. The CPUE values are based on catch number per set of the surface longline (B-gear, 30 hachi, open bars) and per set of the research-mesh gillnet (C-gear, 30 tans, solid bars).

Table 1. A schedule for salmon research cruise of the R/V *Wakatake maru*, summer, 1999.

Date	Items
June 7	Ship research materials and instruments to the vessel
June 8	Depart from Hakodate, Japan
June 9	Begin oceanographic observation and sampling
June 15	Begin fishing operations along the south to north transect in the North Pacific Ocean (180°longitude)
June 27	Enter U.S. 200-mile zone
July 1	Enter the Bering Sea
July 4	Leave the U.S. 200-mile zone
July 8	Complete fishing operations along the south to north transect (180°longitude)
July 8	Begin fishing operations along the east to west transect in the international waters of the Bering Sea
July 15	Complete fishing operations
July 20	Complete oceanographic observation and sampling
July 22	Return to Hakodate, Japan
July 23	Remove samples, materials, and research instruments from the vessel

Table 2. A list of the research items at each research station.

NO	ST	DATE	LAT	LONG	XBT	XCTD	CTD	Primary production	Norpac	Larval Net	Gill-net	Long-line	Remarks
1	T-1	1999 6 9	40 0	150 0 E	○		○	○	○				Calibration of the flowmeter
2	T-2	1999 6 10	40 0	151 0 E	○								
3	T-3	1999 6 10	40 0	152 0 E		○							XCTD was used instead of XBT.
4	T-4	1999 6 10	40 0	153 0 E	○								
5	T-5	1999 6 10	40 0	154 0 E	○								
6	T-6	1999 6 10	40 0	155 0 E	○		○	○	○				
7	T-7	1999 6 11	40 0	156 0 E	○								
8	T-8	1999 6 11	40 0	157 0 E	○								
9	T-9	1999 6 11	40 0	158 0 E	○								
10	T-10	1999 6 11	40 0	159 0 E	○								
11	T-11	1999 6 11	40 0	160 0 E	○		○	○	○				
12	T-12	1999 6 11	40 0	161 0 E	○								
13	T-13	1999 6 11	40 0	162 0 E	○								
14	T-14	1999 6 12	40 0	163 0 E	○								
15	T-15	1999 6 12	40 0	164 0 E	○								
16	T-16	1999 6 12	40 0	165 0 E	○		○	○					
17	T-17	1999 6 12	40 0	166 0 E	○								
18	T-18	1999 6 12	40 0	167 0 E	○								
19	T-19	1999 6 13	40 0	168 0 E	○								
20	T-20	1999 6 13	40 0	169 0 E	○								
21	T-21	1999 6 13	40 0	170 0 E	○			○					CTD was not used under rough water condition.
22	T-22	1999 6 13	40 0	171 0 E	○								
23	T-23	1999 6 14	40 0	172 0 E	○								
24	T-24	1999 6 14	40 0	173 0 E	○								
25	T-25	1999 6 14	40 0	174 0 E	○								
26	T-26	1999 6 14	40 0	175 0 E		○	○	○					XCTD was used instead of XBT.
27	T-27	1999 6 14	40 0	176 0 E	○								
28	T-28	1999 6 15	39 45	177 0 E	○								
29	T-29	1999 6 15	39 30	178 0 E	○								
30	T-30	1999 6 15	39 15	179 0 E	○								
31	ST-1	1999 6 15	39 0	180 0	○		○	○	○	○	○	○	
32	T-31	1999 6 16	39 30	180 0		○							
33	ST-2	1999 6 16	40 0	180 0			○	○	○	○	○	○	
34	T-32	1999 6 17	40 30	180 0		○							
35	ST-3	1999 6 17	41 0	180 0			○	○	○	○	○	○	
36	T-33	1999 6 18	41 30	180 0		○							
37	ST-4	1999 6 18	42 0	180 0			○	○	○	○	○	○	
38	T-34	1999 6 19	42 30	180 0		○							
39	ST-5	1999 6 19	43 0	180 0			○	○	○	○	○		
40	T-35	1999 6 20	43 30	180 0		○							
41	ST-6	1999 6 21	44 0	180 0			○	○	○	○	○		
42	T-36	1999 6 22	44 30	180 0		○							
43	ST-7	1999 6 22	45 0	180 0			○	○	○	○	○		
44	T-37	1999 6 23	45 30	180 0		○							
45	ST-8	1999 6 23, 24	46 0	180 0		○		○	○	○	○		XCTD was used instead of CTD under rough water condition.
46	T-38	1999 6 25	46 30	180 0		○							
47	ST-9	1999 6 25	47 0	180 0			○	○	○	○	○	○	
48	ST-10	1999 6 26	47 30	180 0			○	○	○	○	○	○	
49	T-39	1999 6 27	48 0	180 0		○							
50	ST-11	1999 6 27	48 30	180 0			○	○	○	○		○	
51	T-40	1999 6 28	49 0	180 0		○							
52	ST-12	1999 6 28	49 30	180 0			○	○	○	○		○	
53	T-41	1999 6 29	50 0	180 0		○							
54	ST-13	1999 6 29	50 30	180 0			○	○	○	○		○	
55	T-42	1999 6 30	51 0	180 0		○							
56	ST-14	1999 6 30	51 30	180 0			○	○	○	○		○	

Table 2. Continued.

NO	ST	DATE	LAT	LONG	XBT	XCTD	CTD	Primary production	Norpac	Larval Net	Gill-net	Long-line	Remarks
57	T-43	1999 7 1	52 0	179 40 W		○							Avoided the U.S. territorial waters
58	ST-15	1999 7 1	52 30	180 0			○	○	○	○		○	
59	T-44	1999 7 2	53 0	180 0		○							
60	ST-16	1999 7 2	53 30	180 0			○	○	○	○		○	
61	T-45	1999 7 3	54 0	180 0		○							
62	ST-17	1999 7 3	54 30	180 0			○	○	○	○		○	
63	T-46	1999 7 4	55 0	180 0		○							
64	ST-18	1999 7 4	55 30	180 0			○	○	○	○	○	○	
65	T-47	1999 7 5	56 0	180 0		○							
66	ST-19	1999 7 5	56 30	180 0			○	○	○	○	○	○	
67	T-48	1999 7 6	57 0	180 0		○							
68	ST-20	1999 7 6	57 30	180 0			○	○	○	○	○	○	
69	T-49	1999 7 7	58 0	180 0		○							
70	ST-21	1999 7 7	58 30	180 0			○	○	◎	○	○	○	Additional Norpac (1000m)
71	ST-22	1999 7 8	57 30	179 0 W			○		○	○	○	○	
72	ST-23	1999 7 9	57 30	178 0 W			○		○	○	○	○	
73	ST-24	1999 7 10	56 30	178 0 W			○		○	○	○	○	
74	ST-25	1999 7 11	56 30	179 0 W			○		○	○	○	○	
75	ST-26	1999 7 12	56 30	180 0			○		○	○	○	○	
76	ST-27	1999 7 13	56 30	179 0 E			○		○	○	○	○	
77	ST-28	1999 7 14	56 30	178 0 E			○		○	○	○	○	
78	T-50	1999 7 15	56 30	177 0 E		○							
79	T-51	1999 7 15	56 0	176 0 E		○							
80	T-52	1999 7 15	55 30	175 0 E		○	○	○					
81	T-53	1999 7 15	55 0	174 0 E		○							
82	T-54	1999 7 15	54 30	173 0 E		○							
83	T-55	1999 7 16	54 0	172 0 E		○							
84	T-56	1999 7 16	53 30	171 0 E		○							
85	T-57	1999 7 16	53 0	170 0 E		○	○	○					
86	T-58	1999 7 16	52 20	169 0 E		○							
87	T-59	1999 7 16	51 40	168 0 E		○							
88	T-60	1999 7 16	51 10	167 0 E		○							
89	T-61	1999 7 17	50 40	166 0 E		○							
90	T-62	1999 7 17	50 0	165 0 E		○	○	○					
91	T-63	1999 7 17	49 20	164 0 E		○							
92	T-64	1999 7 17	48 40	163 0 E		○							
93	T-65	1999 7 17	48 0	162 0 E		○							
94	T-66	1999 7 18	47 30	161 0 E		○							
95	T-67	1999 7 18	46 50	160 0 E		○	○	○	○				
96	T-68	1999 7 18	46 10	159 0 E		○							
97	T-69	1999 7 18	45 30	158 0 E		○							
98	T-70	1999 7 18	44 50	157 0 E		○							
99	T-71	1999 7 19	44 10	156 0 E		○							
100	T-72	1999 7 19	43 30	155 0 E		○	○	○	○				
101	T-73	1999 7 19	42 50	154 0 E		○							
102	T-74	1999 7 19	42 10	153 0 E		○							
103	T-75	1999 7 19	41 20	152 0 E		○							
104	T-76	1999 7 20	40 40	151 0 E		○							
105	T-77	1999 7 20	40 0	150 0 E		○	○	○	○				Calibration of the flowmeter

Table 3. Research gears and methods used for collection of data on physical oceanography aboard the R/V *Wakatake maru* 1999.

Gear	Purpose	Specifications	Comments
Conductivity, temperature, and depth sensor (CTD)	Collect temperature and salinity data by depth	Seabird CTD 911+ Made by the Seabird Co. LTD., U.S.	0-1000 m, collected at 27 fishing stations, and other stations at 5° longitude intervals
Expendable Bathy-Thermograph (XBT)	Collect temperature data by depth	XBT Model T-7 Tsurumi-Seiki Co. LTD. Yokohama, Japan	0-760 m, collected at transit stations along the 40°N latitude transect
Expendable conductivity-temperature-depth probe (XCTD)	Collect temperature and salinity data by depth	XCTD Tsurumi-Seiki Co. LTD. Yokohama, Japan	0-1000 m, collected between fishing stations, along the oblique transect returning to Japan, and at fishing staion 8

Table 4. Research gears and methods used for sampling macro-zooplankton aboard the R/V *Wakatake maru* 1999.

Gear	Purpose	Specifications	Comments
Remodeled Norpac Net	Estimate biomass and identification of macro-zooplankton in the epipelagic zone (0-150 m)	Mesh size 0.335 mm; Vertical tow from 150 m to the surface	Collect at all fishing stations; and other stations; and other stations at 5° longitude intervals
Fish Larval Net	Collect fish larvae and large macro-zooplankton (salmon prey)	Mesh size 2.0 mm, Horizontal tow at the surface, ship's speed is 2 knots, tow duration is 10 minutes	Collect at all fishing stations

Table 5. Research gears and methods used for sampling salmon aboard the R/V *Wakatake maru* 1999.

Gear		Purpose	Specifications	Comments
Gillnet	C-gear	Collect salmon and other large pelagic organisms	Length: approx. 50 m Depth: approx. 7.5 m Mesh sizes (mm): 48/55/63/72/82/93/105 /121/138/157, each 3 tans, total 30 tans	Set 16:00 (local time) and hauled 04:00 at surface. Placed in the center of 2 portions of A-gear
	F-gear	Collect juvenile salmon and other small pelagic organisms	Length: approx. 25 m Depth: approx. 7.5 m Mesh sizes (mm): 29/37 each 1 tan, total 2 tans	Placed on one side of A-gear at station 1 to 7
	A-gear	Extend the C-gear in the water so that the C-gear doesn't curl in on itself over the fishing period	Length: approx. 50 m Depth: approx. 7.5 m Mesh sizes: 115 mm, 17 tans at station 1 to 7, 19 tans at station 8 to 28	Placed at both sides of the C-gear
Longline (B-gear)		Collect live salmon and other large pelagic fish species	Length: 111 mm, 49 hooks, 30 hachi, depth: approx. surface to 2 m Bait: salted Japanese anchovy	Set 30 minutes before sunset and hauled 30 minutes after sunset at station 1 to 4 and station 9 to 28. Live salmonids were tagged and released

Table 6. Salmonids, other fishes, and squid catches during the summer salmon research cruise of *Wakatake maru*, 1999, are shown for each station by gear, location, sea water temperature (°C), and salinity (psu) at the surface (1-6 m) and at 100 m are listed. Catch by surface longline (B-gear), salmon reaserch-mesh gillnet (C-gear; meshes=48, 55, 63, 72, 82, 93, 106, 121, 138 and 157 mm), saury reserch-mesh gillnet (F-gear; meshes=29 and 37 mm), and commercial-mesh gillnet (A-gear; mesh=115 mm), and the number of fish tagged with disk tags (some fish also carry an archival tag, and dummy tag) and released are listed for each station.

			Secchi	Temperture		Salinity										Total	Neon	Other	Pacific	Pacific	Lancet		Atka	Walleye	Other
Sta	Date	Location	Depth(m)	Surface	100m	Surface	100m	Gear	Sockeye	Chum	Pink	Coho	Chinook	Steelhead	Salmon	Flying squid	squids	Pomfret	Saury	Fish	Sharks	Mackerel	Pollock	Fishes
1	990615	3900N	11	14.27	10.37	34.23	33.94	B	0	0	0	0	0	0	0	0	0	21	0	0	5	0	0	0
		18000						C	0	0	0	0	0	0	0	68	2	7	0	0	21	0	0	55
								F	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
								A	0	0	0	0	0	0	0	84	2	7	0	0	35	0	0	9
								Total	0	0	0	0	0	0	0	152	5	35	0	0	61	0	0	64
								Released	0	0	0	0	0	0	0									
2*	990616	4000N	11	11.99	9.48	33.84	33.85	B	0	0	0	0	0	0	0	0	0	28	0	0	0	0	0	0
		18000						C	0	0	0	0	0	0	0	26	0	43	55	0	1	0	0	0
								F	0	0	0	0	0	0	0	0	0	0	31	0	0	0	0	0
								A	0	0	0	0	0	0	0	57	0	3	0	0	0	0	0	0
								Total	0	0	0	0	0	0	0	83	0	74	86	0	1	0	0	0
								Released	0	0	0	0	0	0	0									
3	990617	4100N	11	11.86	9.52	33.75	33.84	B	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0
		18000						C	0	0	0	0	0	0	0	108	0	92	1	0	1	0	0	4
								F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
								A	0	0	0	0	0	0	0	141	0	34	0	0	3	0	0	0
								Total	0	0	0	0	0	0	0	249	0	139	1	0	4	0	0	6
								Released	0	0	0	0	0	0	0									
4	990618	4200N	18	8.57	7.45	33.19	33.46	B	0	3	0	4	0	1	8	0	0	2	0	0	0	0	0	0
		18000						C	0	0	1	5	0	0	6	15	3	32	1	0	1	0	0	0
								F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
								A	0	0	0	25	0	0	25	34	0	3	0	0	0	0	0	0
								Total	0	3	1	34	0	1	39	49	3	37	1	0	1	0	0	0
								Released	0	1	0	4	0	0	5									
5	990619	4300N	15	8.06	6.13	33.04	33.20	C	0	2	2	2	0	2	8	0	5	0	0	0	1	0	0	0
		18000						F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
								A	0	1	0	1	0	2	4	0	0	0	0	0	1	0	0	0
								Total	0	3	2	3	0	4	12	0	5	0	0	0	2	0	0	0

Table 6. Continued.

Sta	Date	Location	Depth(m)	Temperture		Salinity		Gear	Sockeye	Chum	Pink	Coho	Chinook	Steelhead	Total Salmon	Neon Flying squid	Other squids	Pacific Pomfret	Pacific Saury	Lancet Fish	Sharks	Atka Mackerel	Walleye Pollock	Other Fishes
				Surface	100m	Surface	100m																		
6	990621	4400N	22	7.06	5.98	32.99	33.10	C	0	3	0	44	0	2	49	0	12	0	0	0	0	0	0	0
		18000						F	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
								A	0	0	1	59	0	7	67	0	0	0	0	0	0	0	0	0
								Total	0	3	1	103	0	9	116	0	12	0	0	0	2	0	0	0
7	990622	4500N	18	7.13	5.81	32.94	33.05	C	0	10	3	3	0	2	18	0	6	0	0	0	0	0	0	0
		18000						F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
								A	0	0	0	12	0	3	15	0	0	0	0	0	0	0	0	0
								Total	0	10	3	15	0	5	33	0	6	0	0	0	0	0	0	0
8**	990624	4600N	10	5.87	3.81	32.44	33.05	C	23	64	8	3	0	4	102	0	2	0	0	0	0	0	0	0
		18000						A	0	1	0	3	1	7	12	0	0	0	0	0	0	0	0	0
								Total	23	65	8	6	1	11	114	0	2	0	0	0	0	0	0	0
9	990625	4700N	16	5.79	3.72	32.85	33.00	B	2	3	2	0	0	0	7	0	0	0	0	0	0	0	0	0
		18000						C	44	32	46	3	4	6	135	0	6	0	0	0	1	0	0	0
								A	4	6	8	0	2	1	21	0	0	0	0	0	0	0	0	0
								Total	50	41	56	3	6	7	163	0	6	0	0	0	1	0	0	0
								Released	2	1	1	0	0	0	4									
10	990626	4730N	20	5.81	3.44	32.87	32.99	B	1	2	4	0	0	1	8	0	0	0	0	0	0	0	0	0
		18000						C	41	60	99	1	2	2	205	0	2	0	0	0	0	0	0	0
								A	7	6	7	4	2	3	29	0	0	0	0	0	0	0	0	0
								Total	49	68	110	5	4	6	242	0	2	0	0	0	0	0	0	0
								Released	0	1	1	0	0	0	2									
11	990627	4830N	18	6.14	3.74	32.76	32.93	B	1	11	4	0	0	0	16	0	0	0	0	1	0	0	0	0
		18000						Released	0	6	1	0	0	0	7									
12	990628	4930N	14	5.78	3.02	32.87	33.02	B	3	3	4	0	0	0	10	0	0	0	0	1	0	0	0	0
		18000						Released	1	2	0	0	0	0	3									
13	990629	5030N	14	6.26	3.66	32.63	32.29	B	3	8	9	0	0	0	20	0	0	0	0	0	0	0	0	0
		18000						Released	1	4	4	0	0	0	9									
14	990630	5130N	17	4.78	3.27	33.12	33.29	B	6	2	22	1	0	0	31	0	0	0	0	0	0	1	0	0
		18000						Released	3	0	11	1	0	0	15									
15	990701	5230N	15	4.87	3.89	33.17	33.31	B	4	2	15	1	0	0	22	0	0	0	0	0	0	0	0	0
		18000						Released	3	1	8	0	0	0	12									
16	990702	5330N	11	7.00	2.43	33.04	33.13	B	1	3	25	0	1	0	30	0	0	0	0	0	0	0	0	0
		18000						Released	1	2	14	0	1	0	18									

Table 6. Continued.

Sta	Date	Location	Depth(m)	Temperture		Salinity		Gear	Sockeye	Chum	Pink	Coho	Chinook	Steelhead	Total Salmon	Neon Flying squid	Other squids	Pacific Pomfret	Pacific Saury	Lancet Fish	Sharks	Atka Mackerel	Walleye Pollock	Other Fishes
				Surface	100m	Surface	100m																		
17	990703	5430N	12	7.00	2.09	32.96	33.07	B	0	10	6	0	0	0	16	0	0	0	0	0	0	0	0	0
		18000						Released	0	3	2	0	0	0	5									
18	990704	5530N	13	6.33	2.69	32.97	33.13	B	3	26	10	0	0	0	39	0	0	0	0	0	0	0	0	0
		18000						C	15	83	188	0	0	0	286	0	3	0	0	0	0	0	0	0
								A	11	110	284	0	1	0	406	0	0	0	0	0	0	0	0	0
								Total	29	219	482	0	1	0	731	0	3	0	0	0	0	0	0	0
								Released	3	19	4	0	0	0	26									
19	990705	5630N	13	5.73	1.43	32.90	32.98	B	1	28	19	0	0	0	48	0	0	0	0	0	0	0	0	0
		18000						C	12	40	219	0	1	0	272	0	0	0	0	0	0	0	0	0
								A	8	54	254	0	2	0	318	0	0	0	0	0	0	0	0	0
								Total	21	122	492	0	3	0	638	0	0	0	0	0	0	0	0	0
								Released	1	16	7	0	0	0	24									
20	990706	5730N	12	5.79	1.19	32.95	33.03	B	2	10	16	0	0	0	28	0	0	0	0	0	0	0	0	0
		18000						C	25	50	296	0	3	0	374	0	4	0	0	0	0	0	0	0
								A	8	60	602	0	4	0	674	0	0	0	0	0	0	0	0	0
								Total	35	120	914	0	7	0	1076	0	4	0	0	0	0	0	0	0
								Released	0	7	8	0	0	0	15									
21	990707	5830N	14	6.35	2.62	32.86	33.04	B	2	2	34	0	0	0	38	0	0	0	0	0	0	0	0	0
		18000						C	62	59	493	0	11	0	625	0	0	0	0	0	0	0	0	0
								A	24	95	556	0	5	0	680	0	0	0	0	0	0	0	0	0
								Total	88	156	1083	0	16	0	1343	0	0	0	0	0	0	0	0	0
								Released	1	1	17	0	0	0	19									
22	990708	5730N	15	6.30	2.07	32.88	33.05	B	1	10	3	0	0	0	14	0	0	0	0	0	0	0	0	0
		17900W						C	14	32	309	0	2	0	357	0	0	0	0	0	0	0	0	0
								A	20	32	473	0	3	0	528	0	0	0	0	0	0	0	0	0
								Total	35	74	785	0	5	0	899	0	0	0	0	0	0	0	0	0
								Released	0	5	1	0	0	0	6									
23	990709	5730N	16	6.49	2.26	32.79	33.01	B	0	1	15	0	0	0	16	0	0	0	0	0	0	0	0	0
		17800W						C	23	37	618	0	5	0	683	0	0	0	0	0	0	0	0	0
								A	29	38	850	0	7	0	924	0	0	0	0	0	0	0	0	0
								Total	52	76	1483	0	12	0	1623	0	0	0	0	0	0	0	0	0
								Released	0	1	6	0	0	0	7									
24	990710	5630N	13	6.64	2.17	32.90	33.03	B	1	73	23	0	2	0	99	0	0	0	0	0	0	0	0	0
		17800W						C	9	54	278	0	5	0	346	0	6	0	0	0	0	0	0	1
								A	8	85	421	0	4	0	518	0	0	0	0	0	0	0	0	0
								Total	18	212	722	0	11	0	963	0	6	0	0	0	0	0	0	1
								Released	0	44	8	0	1	0	53									

Table 6. Continued.

Sta	Date	Location	Depth(m)	Temperture Surface	Temperture 100m	Salinity Surface	Salinity 100m	Gear	Sockeye	Chum	Pink	Coho	Chinook	Steelhead	Total Salmon	Neon Flying squid	Other squids	Pacific Pomfret	Pacific Saury	Lancet Fish	Sharks	Atka Mackerel	Walleye Pollock	Other Fishes
25	990711	5630N	15	6.91	1.67	32.88	33.02	B	1	69	78	0	1	0	149	0	0	0	0	0	0	0	0	0
		17900W						C	10	117	423	0	2	0	552	0	4	0	0	0	0	0	0	0
								A	20	131	459	0	0	0	610	0	0	0	0	0	0	0	0	0
								Total	31	317	960	0	3	0	1311	0	4	0	0	0	0	0	0	0
								Released	0	52	14	0	0	0	66									
26	990712	5630N	13	6.80	1.53	32.88	32.99	B	0	29	11	0	0	0	40	0	0	0	0	0	0	0	0	0
		18000						C	31	114	294	0	9	0	448	0	4	0	0	0	0	0	0	0
								A	29	146	425	0	4	0	604	0	0	0	0	0	0	0	0	1
								Total	60	289	730	0	13	0	1092	0	4	0	0	0	0	0	0	1
								Released	0	25	4	0	0	0	29									
27	990713	5630N	16	6.97	1.59	32.89	33.07	B	0	41	7	0	3	0	51	0	0	0	0	0	0	0	0	0
		17900E						C	50	69	508	0	5	0	632	0	2	0	0	0	0	0	0	0
								A	17	78	408	0	2	0	505	0	0	0	0	0	0	0	0	0
								Total	67	188	923	0	10	0	1188	0	2	0	0	0	0	0	0	0
								Released	0	32	5	0	0	0	37									
28	990714	5630N	15	7.32	1.60	32.91	33.03	B	0	24	41	0	0	0	65	0	0	0	0	0	0	0	0	0
		17800E						C	29	50	304	0	2	0	385	0	1	0	0	0	0	0	0	0
								A	18	65	303	1	3	0	390	0	0	0	0	0	0	0	0	0
								Total	47	139	648	1	5	0	840	0	1	0	0	0	0	0	0	0
								Released	0	18	18	0	0	0	36									
		TOTAL						B	32	360	348	6	7	2	755	0	0	64	0	2	5	1	0	0
								C	388	876	4089	61	51	18	5483	217	62	174	57	0	26	0	0	60
								F	0	0	0	0	0	0	0	0	1	0	31	0	2	0	0	2
								A	203	908	5051	105	40	23	6330	316	2	47	0	0	39	0	0	10
								Total	623	2144	9488	172	98	43	12568	533	65	285	88	2	72	1	0	72
								Released	16	241	134	5	2	0	398									
								%Comp	5.0	17.1	75.5	1.4	0.8	0.3	100.0									

*The gillnet was retrived at 00:39 (instead of the usual 04:00), which reduced the soak time to approximately three hours.

**Length of A-gear section of gillnet was increased from 17 to19 tans at stations 8 to 28.

Table 7. A record of temperature tags on salmonids released in the North Pacific Ocean and the Bering Sea from longline fishing operations conducted by the R/V *Wakatake maru* in June and July, 1999. FL=fork length (mm), FAJ=Fisheries Agency of Japan, FRI=Fisheries Research Institute.

Temperature	Release	Release Location		Disk Tag Numbers		Species	FL
Tag No.	Date	Latitude	Longitude	FAJ	FRI		
225	25-Jun-99	4700N	18000	HH2138	LL2909	sockeye	583
231	28-Jun-99	4930N	18000	HH2154	LL2925	sockeye	550
239	29-Jun-99	5030N	18000	HH2165	LL2936	sockeye	543
236	2-Jul-99	5330N	18000	HH2200	LL2966	chum	614
247	2-Jul-99	5330N	18000	HH2212	LL2983	chum	601
253	4-Jul-99	5530N	18000	HH2226	LL2997	chum	572
256	4-Jul-99	5530N	18000	HH2227	LL2998	chum	608
263	6-Jul-99	5730N	18000	HH2281	LL3052	chum	590
270	10-Jul-99	5630N	17800	HH2346	LL3117	chum	569
284	10-Jul-99	5630N	17800	HH2356	LL3127	chum	499

Table 8. A record of archival tags released on salmonids caught in the Bering Sea from longline fishing operations conducted by the R/V *Wakatake maru* in July, 1999. FL=fork length (mm), FAJ=Fisheries Agency of Japan, FRI=Fisheries Research Institute.

Archival	Release	Release Location		Disk Tag Numbers		Species	FL
Tag No.	Date	Latitude	Longitude	FAJ	FRI		
1238	4-Jul-99	55°30N	180°00	HH2218	LL2989	chum	475
1239	4-Jul-99	55°30N	180°00	HH2219	LL2990	chum	572
1183	5-Jul-99	56°30N	180°00	HH2245	LL3016	chum	569
1198	5-Jul-99	56°30N	180°00	HH2260	LL3031	chum	512
1220	6-Jul-99	57°30N	180°00	HH2277	LL3048	chum	584
1182	6-Jul-99	57°30N	180°00	HH2279	LL3050	chum	576
1199	6-Jul-99	57°30N	180°00	HH2282	LL3053	chum	560
1179	8-Jul-99	57°30N	179°00W	HH2303	LL3074	chum	604
1241	9-Jul-99	57°30N	178°00W	HH2309	LL3080	chum	540
1231	10-Jul-99	56°30N	178°00W	HH2316	LL3087	chum	517
1125	10-Jul-99	56°30N	178°00W	HH2317	LL3088	chum	540
1230	10-Jul-99	56°30N	178°00W	HH2318	LL3089	chum	511
1033	10-Jul-99	56°30N	178°00W	HH2335	LL3106	chum	570
1036	11-Jul-99	56°30N	179°00W	HH2369	LL3140	chum	640
1038	11-Jul-99	56°30N	179°00W	HH2373	LL3144	chum	637
1058	11-Jul-99	56°30N	179°00W	HH2388	LL3159	chum	616
1065	11-Jul-99	56°30N	179°00W	HH2390	LL3161	chum	584
1051	12-Jul-99	56°30N	180°00	HH2435	LL3206	chum	616
951	12-Jul-99	56°30N	180°00	HH2436	LL3207	chum	516
948	12-Jul-99	56°30N	180°00	HH2443	LL3214	chum	524
1035	12-Jul-99	56°30N	180°00	HH2445	LL3216	chum	624
1120	13-Jul-99	56°30N	179°00E	HH2464	LL3235	chum	579
803	13-Jul-99	56°30N	179°00E	HH2474	LL3245	chum	583
1104	13-Jul-99	56°30N	179°00E	HH2483	LL3254	chum	601
256	13-Jul-99	56°30N	179°00E	HH2496	LL3267	chum	649
894	14-Jul-99	56°30N	178°00E	HH2501	LL3272	chum	590